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Red velvet mite (*Trombidium grandissimum)* and its extreme strategies for survival

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ABSTRACT

Trombidium grandissimum belonging to the subclass Acari and family Trombidiidae are very much common in the central plateau region of India. These mites, having peculiar morphological, physiological and behavioural characteristics are perfect example of adaptive evolution. Their extreme habitat and mode of living shows their adaptive power to cope up with harsh environment. We have chosen these less studied Trombidiidae mites as our subject to explain how environment plays the most significant role in moulding the characteristics of an organism through evolution. Here, in this experiment, we have studied its various behavioural and morphological traits which stand as valid support in defining its adaptation to extreme climate. Comparing these amazing creatures with others species, belonging to the same family (Trombidiidae) or same class (Arachnida), provides valid proof of their evolutionary modification.

Key words: *Trombidium grandissimum*, red velvet mite, behaviour, morphology, extreme adaptation.

1. INTRODUCTION

Life started with a single cell which gradually change to multicellular organisms with the course of evolution. With time complexity has increased and evolution paved its path facilitating adaptation and survival of different forms of life in extreme climatic changes and new environments (Shanahan T (2004)). Like other animals Arachnids also undergo various adaptation to provide best fit in that environment (M. Canals (2015)). The adaptation may be in the form of food-habit, environment, structure or its behaviour (S. Liu 2015; A. Walzer 2015). Thus each family has its unique feature for adaptation. Among other families, mites belonging to Trombidiidae are less studied.

Among Trombidiidae, *Allothrombium lerouxi* is known to be predatory in nature (Moss 1960). It undergoes hibernation and only comes out during breeding season. The emergence of the Trombidiidae mites, on the soil surface depends on sunshine, rainfall and moisture content of the surrounding air (Robaux, 1974). *Trombidium grandissimum* another member of this family is well known as "Badal kida" in India. They are seen after rain and also known as "rain bug" in other parts of the world. Their soft cushioning skin is covered with bright red coloured hairs. These mites are terrestrial and burrowing in nature and lives in soil burrow. T. *grandissimum* are mostly found in the dry, arid, desiccating regions where the climate is of extreme type. In India, these are found more in the central plateau region. These mites are predatory in nature and feeds on termites and eggs of other insects, like ants. Though belonging to the order Acariforms, they share many similarities with the order Araneae (Ruppert, 2004). This creature is not only famous for its bright red velvety body which looks astonishing but also famous for its therapeutic usage in the treatment of paralysis and sexual dysfunction (Oudhia 2003). This definitely shifted the aim of the scientists and researchers towards its curative properties. As a result of this, very little studies have been done on its behaviour and physiology and very little is known about these Arachnids. Behaviour is often described as the outcome of the morphological and physiological evolution of an organism in response to the environmental changes (Duckworth 2008). Hence, the aim of this project was to study the behavioural and physiological traits of this mite in order to analyse its adaptation in extreme weather conditions.

2. MATERIALS AND METHODS

Sample Collection

T. *grandissimum* were collected from National Institute of Technology, Rourkela, Odisha, India of longitude 84°54'5.90" E and latitude 22°15'11.79" N during monsoon (June and July 2017-2018). These bright, red, little creatures are found to wriggle out of their holes generally during the early morning when sunlight falls on the ground and then they move around in search of food till about 10 to 11 am. They are classified into five developmental stages viz. egg, larva, nymph, intermediary stage and adult as per the staging made by Zhang (Zhang 1999). Various stages were collected during this time of the day in the month of June.

Morphological studies

Measurement of body length:

Body length of the T. *grandissimum*, belonging to different developmental stages were measured by taking photographs of them along with a ruler as a scale of reference and then calculating its length from the anterior end of the mites to the posterior end, by a computer aided software called 'Image j'.

Analysis of different body parts by Microscopy:

The mites were observed under stereo microscope for detailed classification and analysis of different parts of their body. (1)Eyes and different parts of T. *grandissimum* were observed and imaged under stereo microscope. (2)For high resolution imaging of microscopic structures samples were processed for ESEM and FESEM.

For ESEM body parts were dissected out and mounted on a double-sided adhesive black carbon tape fixed on small pieces of glass slides. Then the samples were viewed under Environment Scanning Electron Microscope (QUANTA FEG 250) different magnifications with an operating voltage of 10kV.

For FESEM, the part of T. *grandissimum* to be imaged was first dissected out and kept for few days to dry. Then the sample, fixed on a black carbon tape was given for gold coating under an Icon Analytic coating machine for one hour and then viewed under FEI Field Emission Scanning Electron Microscope (NOVA NANOSEM 450) at different magnifications with an operating voltage of 10kV.

UV gel doc imaging:

Mites were anaesthetised and imaged under trans-UV and epi-white light in a UV gel doc machine (BIORAD Gel Doc UV).

Behavioural Study

To study the role of vision in behaviour several studies were performed.

Response to light and dark:

To study the response of the animal towards light or dark six mites were taken in a conical flask and were kept in an absolutely dark room for 1 hour. With the onset of time mites were introduced to a T maje device (Mishra and Barik, 2018) and their behaviour were observed. The number of animals in dark/light chamber was calculated after 10 minutes.

The polarised light vision:

Glass, plastic cup, water droplet, ice cubes known to reflect polarised light from their surfaces. These materials were placed on a large tray and six mites were released at the centre of the tray and were allowed to move freely and were observed for 2 minutes to see whether they were showing any attraction towards those objects.

The light sensitivity test:

Six mites were taken on a tray and strong beam of polychromatic white light was focused on the mites and their response towards the light was observed.

The colour and pattern recognition test:

A large tray was taken where five flowers, each of different colours were kept randomly and then six of the mites were released onto it. Their movements were observed for 2 minutes to find out whether they have any preference towards any colour. The experiment was repeated six times. Similarly for the pattern recognition study longitudinal, horizontal and diagonal stripes (1.5mm thick) were drawn on triangular, circular and rectangular paper cut outs with black ink and those patterns were kept randomly on a large tray. Then six T. *grandissimum* were released on it and their movements were observed for 2 minutes. The whole experiment was repeated for six times.

Angle of vision:

In order to characterise its vision and sight, another test was done, where six mites were released on a large tray and were allowed to move freely. Then an object (a paint brush wrapped with tissue paper) was kept at different positions forming different angles with the exo-skeletal surface, along the path of their movement and the change in the direction of their movement was noticed.

Taste sensitivity:

Four different elements, honey, termites, poisonous insect (*Antilochus conquebertii*) and ethanol (sterile cotton soaked in absolute ethanol) were kept on a large tray at an equal distance apart from the centre of the tray. Then six T. *grandissimum* were released at the centre of the tray and their movements were observed. This was repeated six times and a chart mentioning how many times they were moving towards each particular element in each run was made.

Touch sensitivity test:

Six of these mites were taken as samples in a tray for the touch sensitivity test. Three types of touch were given viz. very soft touch, mild touch and harsh touch. For the very soft touch eyelash glued on a toothpick was used. For the mild touch the bristles of a soft paint brush was used. And for the harsh touch a glass rod was used. The changes in the behaviour of the mites in response to those touches were observed.

Variation in speed:

T. *grandissimum* were taken with known body length and they were allowed to move freely on a blank paper. The path traverse by each of the spiders and the time required were noted and the experiment was repeated six times to get the mean value. The average speed (=distance/time) was calculated for each of them and the values were plotted on a graph against their corresponding body length.

Variation in side reflex:

Side reflex test was done by measuring the time taken by each of the mites to roll back to their normal position after they had been forcefully laid on their backs. The time taken by each of the mites to roll back was observed for six times and mean time was

calculated for each them. Then a graph was plotted with the body length along the 'X' axis and time taken to roll back along the 'Y' axis.

Temperature sensitivity test:

To see how these creatures endure heat, six T. *grandissimum* were taken, one or two at a time, and were kept on a magnetic stirrer (Tarsons Digital Spinot) set to 40°C and zero rpm and observed. Then the temperature of the stirrer was slowly increased to 50°C and then to 60°C and the changes in their behaviour were observed. To recheck its ability to tolerate high temperature the mites were taken on a hot plate with temperature set to 50°C and observed.

Again another set of six mites were taken on a large tray and ice cubes were kept on the tray. Their movements were observed for 2 minutes of time and the experiment was repeated with another set of six mites.

Sensitivity towards chemicals like ether:

They were brought in contact with Ether in order to make them senseless and their response towards those chemical was observed.

Starvation and dehydration test:

Two conical flasks were taken and in each of them six mites (different body lengths) were kept and the mouth of the flasks were plugged with sterile cotton and the whole set up was kept at room temperature and normal humidity condition for several days and were observed.

Food habitat test:

The mites were studied for several hours in their natural habitat to find out their food habits and other characteristic behaviours. The most preferred time for this was in the morning, at 6'O clock when the maximum number of mites were found scattered on the field.

3. RESULTS

Morphological Study

Body length variation:

With the measured body lengths of *T.grandissimum* at different developmental stages a graph was plotted, having body length along the Y-axis and number of samples along the X-axis, and it was observed that the maximum variation in the body length occurs during the intermediate stage (Fig.1). The average length of the adult T. *grandissimum* is found to be (1.1589±0.05005) cm, where the Intermediate stage is found to be (0.927±0.159) cm and the Nymphs are approximately (0.4895±0.0087) cm in length.

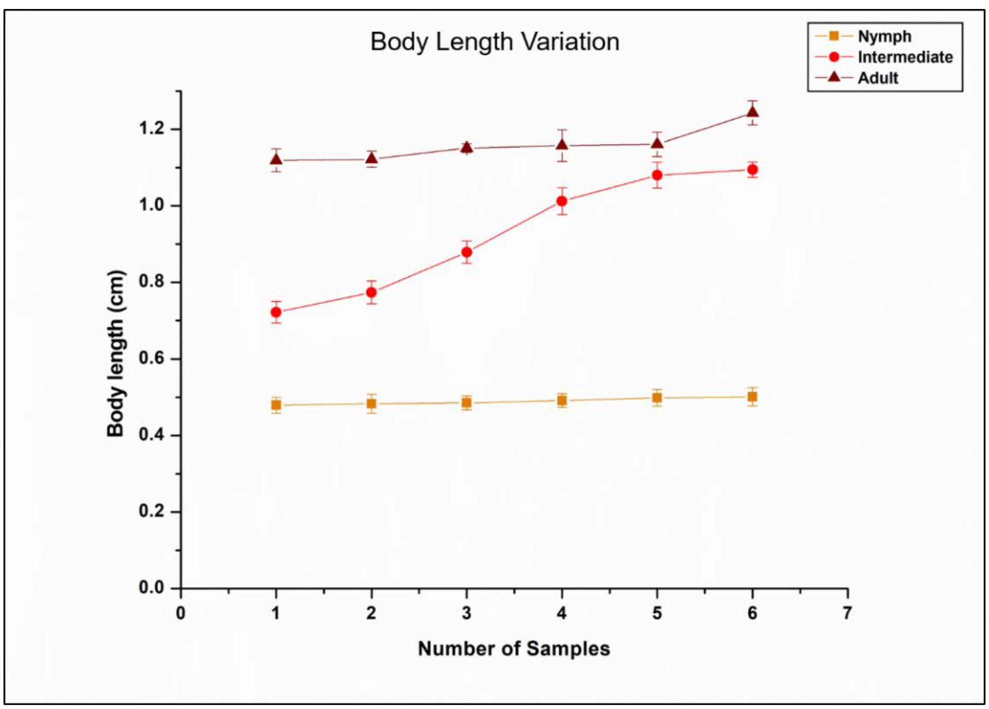

Fig.1 Graph showing variation in body length in different stages of T. *grandissimum*

Analysis of body parts by different microscopic techniques:

From ESEM images it was found that they have stalked eyes (Fig.2e; f) with two lenses pointing towards different directions (Fig.2g). They have thick covering of hairs on their body (Fig.2h; i; j). Their front legs having shorter hairs at the distal end which look like sensilla (Fig.2c). They have claws on all the four pairs of their legs (Fig.2d).

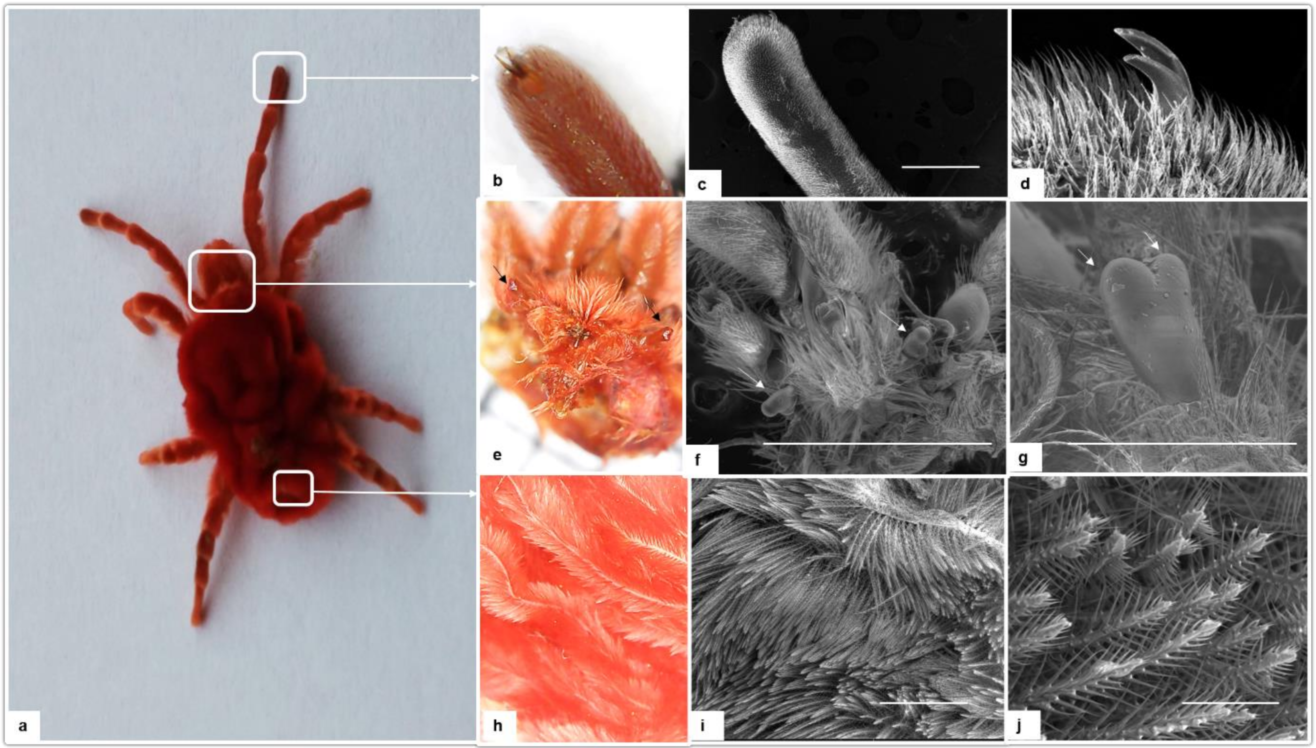

Fig.2 (a) Top view of T. *grandissimum* showing its different body parts. (b) Digital microscopic image of the distal part of the front leg. **(c)** FESEM image of the front leg showing short sensillary hairs and claws at the tip. Scale bar = 500µm. **(d)** FESEM magnified view of the claws. **(e)** Digital microscopic image of the dissected head with eyes on both side pointed with black arrows. **(f)** ESEM image of the head showing the stalked eyes pointed with white arrows. Scale bar = 1mm. **(g)** Magnified ESEM image of one eye with two lenses oriented in two different directions pointed with white arrows. Scale bar = 400µm. **(h)** Digital microscopic image of the red velvety skin. **(i)** ESEM image of the skin showing the tuft of hairs covering it. Scale bar = 500µm. **(j)** ESEM image of body hairs showing the branches and arrangement. Scale bar = 50µm

UV gel doc:

From the image taken under epi-white light and trans-UV, both the dorsal and ventral part of their bodies show UV signal at the side of their body (Fig.3).

Behavioural Studies

Response towards light and dark:

It was found that they became standstill or performing very less movement while kept in the dark. They were moving from the dark chamber to the light illuminated chamber. Within few minutes of time all six of the mites, taken for the experiment, shifted to the light chamber. In the light chamber they were showing very faster movements and were seemed to get excited in presence of light.

Polarized light vision:

The mites were found to cluster around the objects which have the property to polarise a beam of polychromatic light like ice-cubes, plastic glass and water droplet which proves they can sense polarised light and gets attracted towards it (Fig.4a; b; c).

Sensitivity towards polychromatic white light:

T. grandissimum were found to be very much sensitive towards light and they become activated when light was focused on them with a torch. They were found to climb up to the source of light, being attracted towards it.

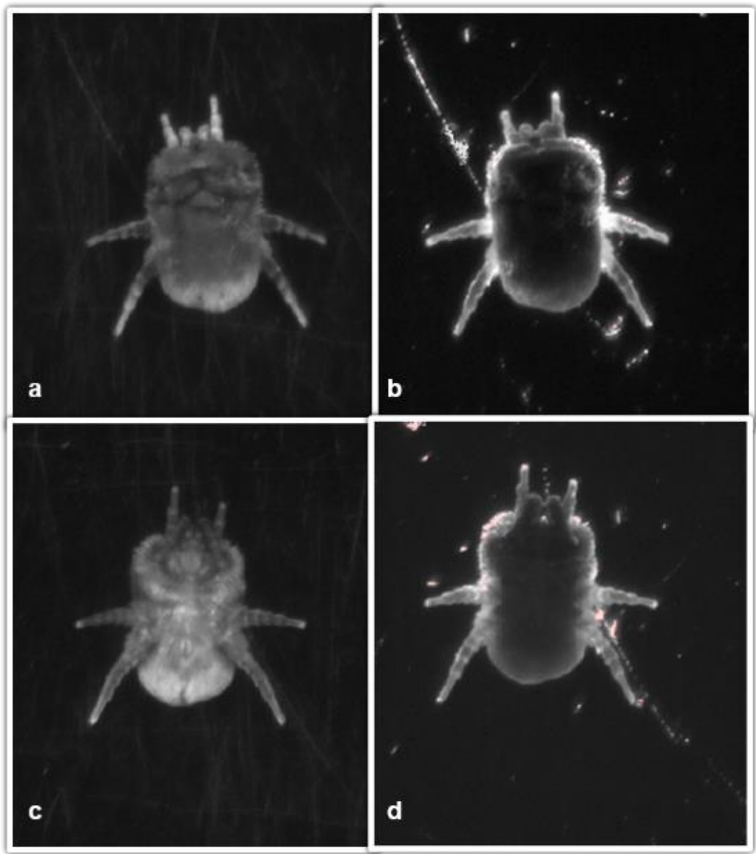

Fig.3 (a) Epi-white image of the dorsal part of T. *grandissimum*. **(b)** UV image of the dorsal part of T. *grandissimum*. **(c)** Epi-white image of the ventral part of T. *grandissimum*. **(d)** UV image of the ventral part of T. *grandissimum*

Colour discrimination and pattern recognition:

When they released on a tray with different coloured flowers they were found to be unable to distinguish any colour since they were moving randomly on the tray without showing any preference towards any particular colour. Also they could not recognise patterns since they were moving unaware of the patterns kept on their path.

Eye sight:

These mites have very poor eye sight. They could not see any object which was kept directly at the front and were moving straight towards it, being unaware of the obstacle kept in front of their path, until and unless they were sensing the object with their front legs. But when the object was kept at an elevation, slightly above the ground and very near to the mites, they were not moving any further, suggesting that they could see objects kept in the front slightly above the horizontal level. When the object was kept on top of their head the mites could not sense anything. However, they have good lateral vision and could see objects which were kept on the lateral side of their heads. In such case, they were turning towards the other side of the obstacle.

Taste sensitivity:

The experimental setup was consist of a tray with termites, honey, cotton soaked in ethanol and a poisonous insect body kept at equal distance apart from the centre point (Fig.4b). When released on that tray, *T. grandissimum* were moving more towards the termite and the honey. Some started feeding on the termites. Whereas on the other hand it was found that they were immediately reverting back after sensing the poisonous insect. Not a single one of them were found to move towards the cotton soaked in ethanol (Fig.5).

Touch sensation:

They were found to be very sensitive towards touch. Although they did not show any response towards very soft touch with the eyelash (Fig.4e) but they could sense mild touch as they were expanding their body on mild touch with a painting brush (Fig.4f).

When the mites were struck with a twig they were contracting their bodies (Fig.4g).They pretend to be dead for about one to two minutes before coming back to their original shape.

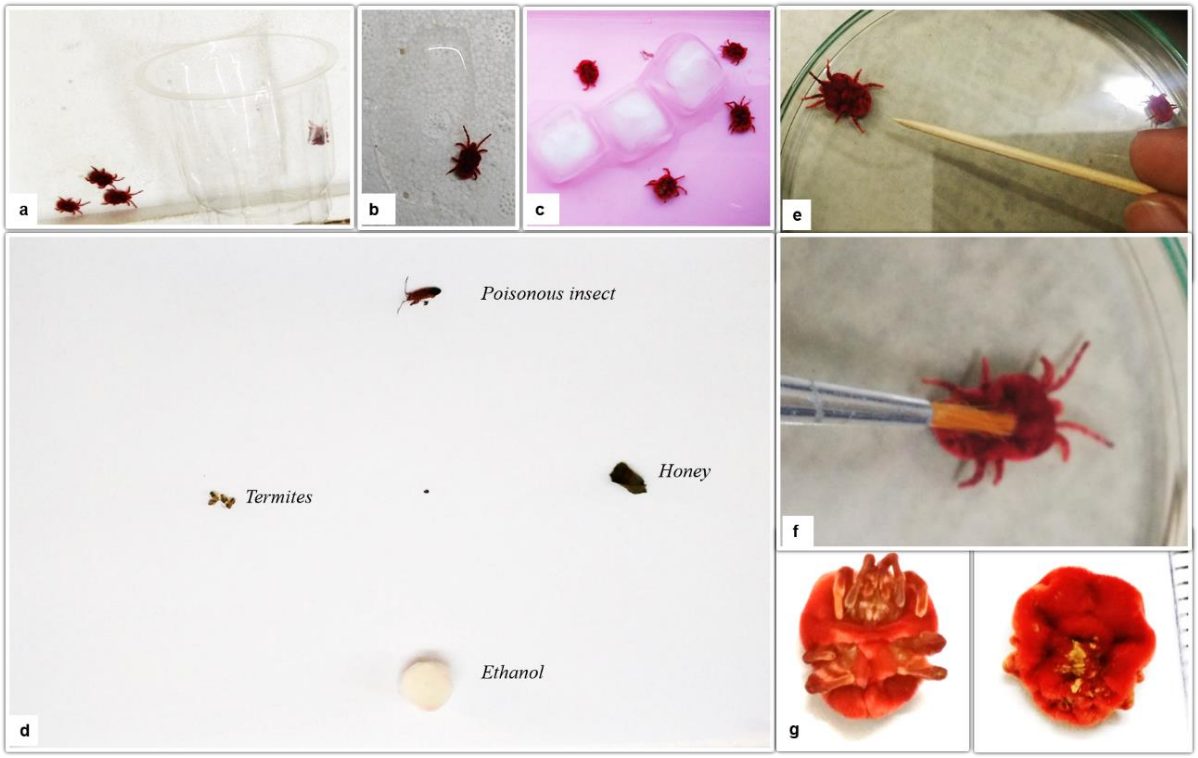

Fig. 4 T. *grandissimum* attracted towards polarized light reflecting objects viz. **(a)** plastic glass, **(b)**water drop and **(c)** ice cubes. **(d)** Taste sensitivity set up. **(e)** Soft touch with eyelash glued on a toothpick. **(f)** Mild touch with soft paint brush. **(g)** T. *grandissimum* on being touched harshly with a twig

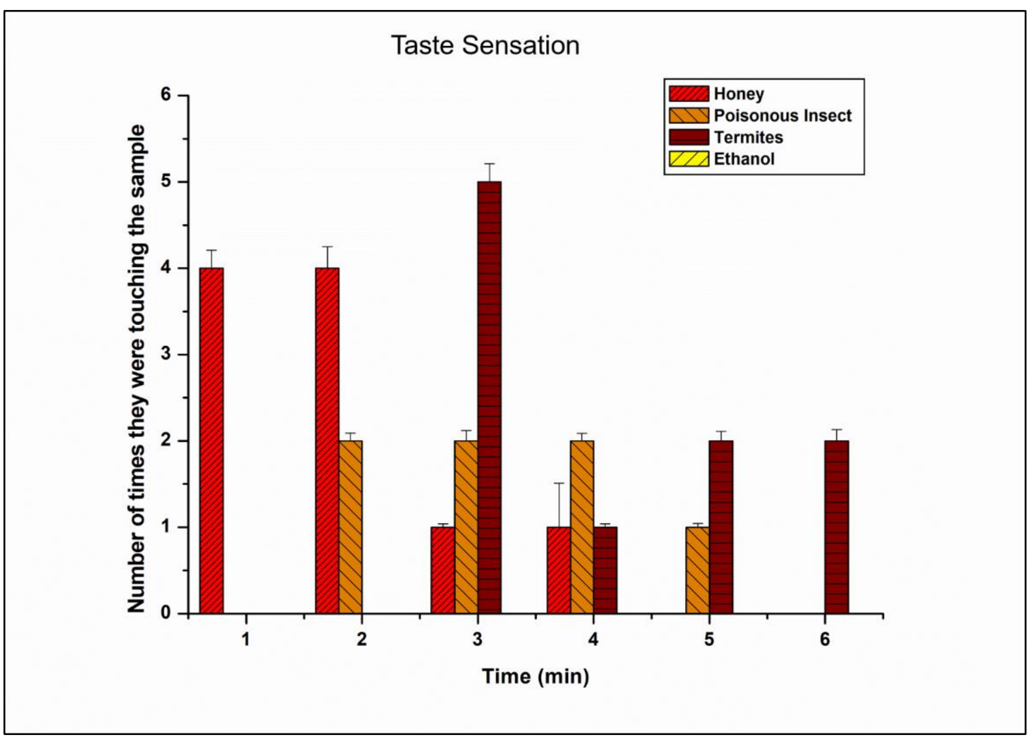

Fig.5 Graph showing taste preference of T. *grandissimum*

Speed variation:

From the speed test graph, we observed that the smaller ones were moving with a greater speed while the larger ones were moving slowly (Fig.6a).

Side reflex:

After performing the side reflex test on different stages of mites, the side reflex graph was plotted. Analysing the graph it can be concluded that he smaller ones were taking more time to revert back while the larger ones were reverting back instantly (Fig.6b).

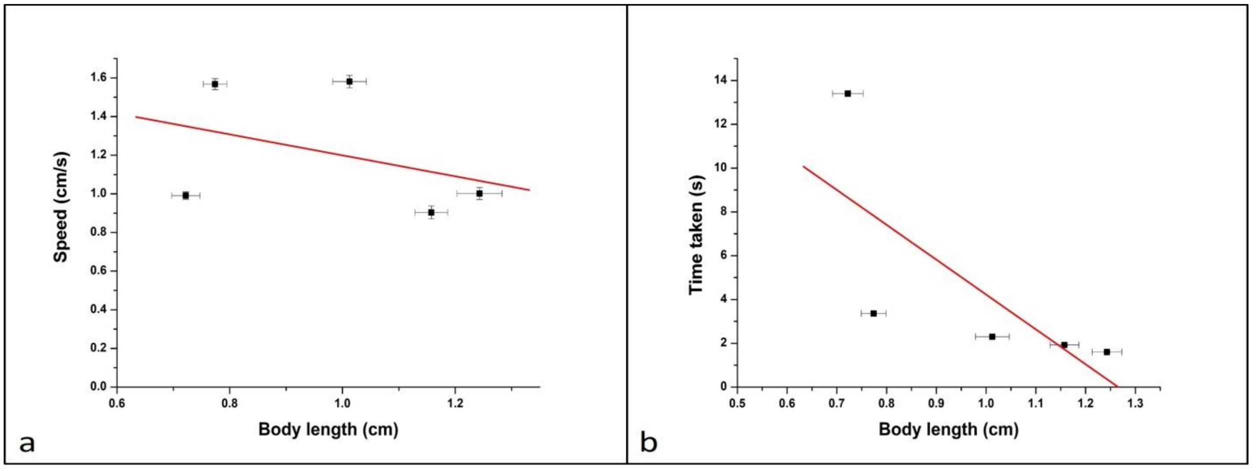

Fig.6 (a) Graph showing variation in speed of T. *grandissimum* in relation with the body length. **(b)** Graph showing variation in time taken to turn over (side reflex) by T. *grandissimum* in relation with the body length

Temperature sensitivity:

During the heat shock, at 40°C, they did not show any remarkable changes in their behaviour. As the temperature was raised to 50°C they were moving very fast trying to escape the heated base of the magnetic stirrer. Also during this time they were contracting their bodies to pretend to be dead even on mild touch with a paint brush. The result was similar when the mites were kept on the hot plate at 50°C temperature. While the temperature was raised to 60°C the mites slowly became numb as their leg hairs were burning due to high temperature. They could not walk properly and was gradually becoming silent. Within few minutes they died.

While during the cold shock they were at first moving towards the ice-cubes but after sensing them with their front legs they were immediately retrieving back.

Sensitivity towards chemicals:

They were found to have strong resistance power towards ether and does not show any significant change towards Ether.

Resistance towards starvation and dehydration:

When *T. grandissimum* were kept for a week without food and water in a petri-dish the nymph were died. While the adults continued to live but their activities were found to get reduced. Two weeks after starvation their skin colour darkened and became loose and wrinkled as if they were undergoing dehydration. But they were still alive for three to four weeks without any food. The intermediate T. *grandissimum* were losing their moisture content faster than the larger adult ones and died earlier than the adult stage (Fig.7). After several days of starvation when water droplets were introduced into the petri-dishes they were found to get attracted towards those droplets and after rapid tapping movement of their front legs to sense the drop of water they were found to inserting their mouth parts inside and drink water from those drops. The smaller ones were often found to float on those water droplets.

Food search in habitat:

They were found to come out of their burrows early in the morning and crawl on the ground in search of food (Fig.8b). They prefer to feed on dead insects, eggs of ants and termites. They wriggle their bodies through tiny ant holes and feed on their eggs (Fig.8c).

Also, after death these mites are found to be eaten up by ants or other insects (Fig.8d). These mites were found to perform encircling dance which may be done in order to attract the opposite sex for breeding.

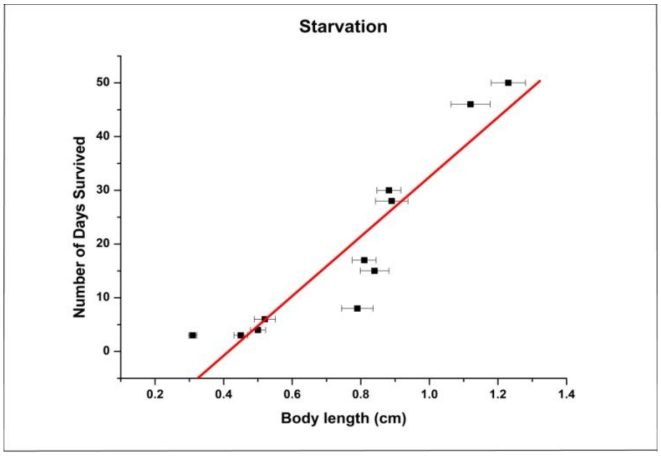

Fig.7 Graph showing starvation ability of T. *grandissimum* in relation with their size of the body

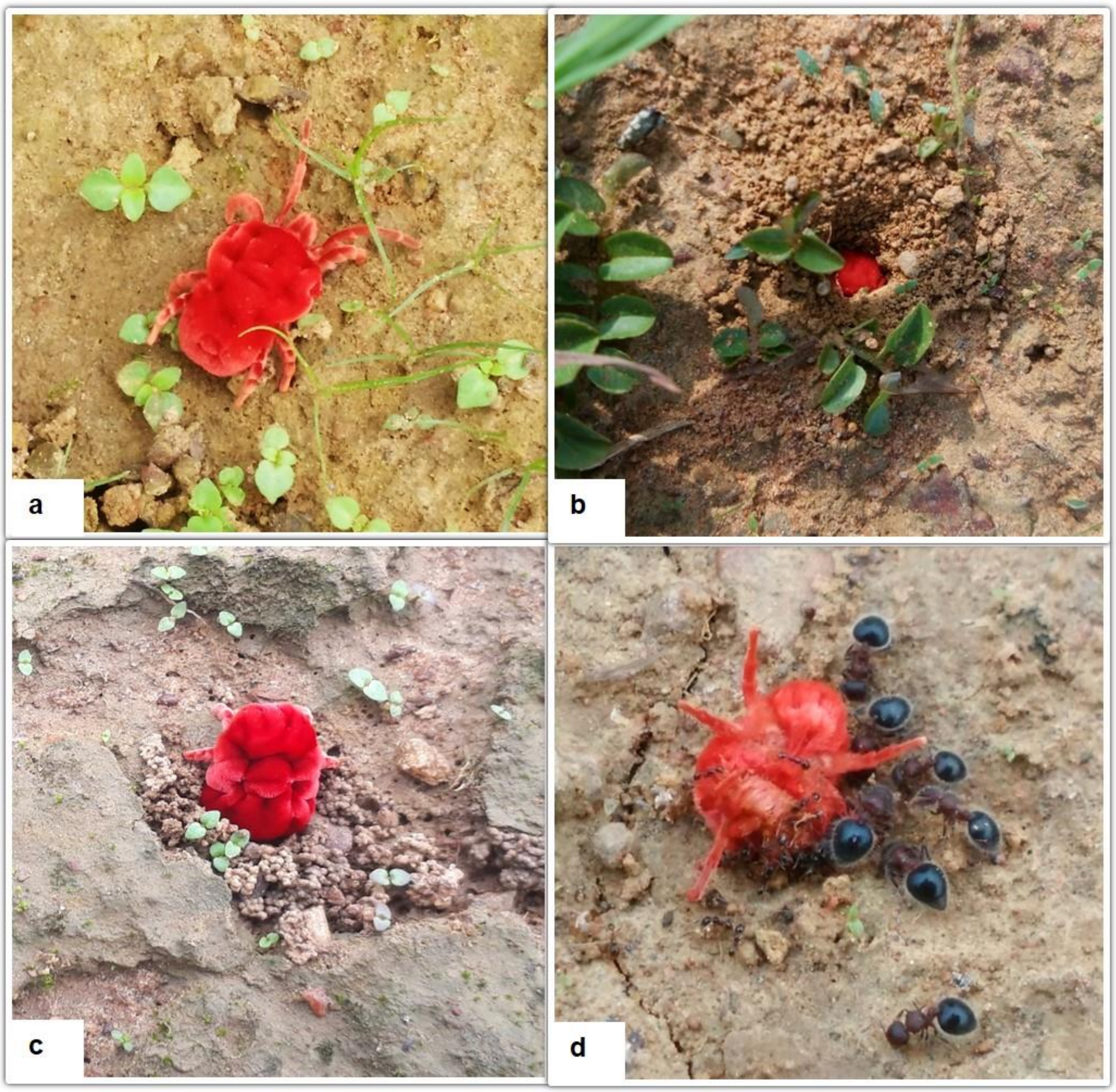

Fig.8 (a) T. *grandissimum* in its natural habitat **(b)** Image of T. *grandissimum* in soil burrow. **(c)** T. *grandissimum* searching for ant eggs in ant burrows. **(d)** Dead T. *grandissimum* being eaten up by a group ants.

4. DISCUSSION

Although T. *grandissimum* belongs to the order Acari, these mites share similarity with that of a spider for which they are often misidentified as spiders. This indicates the evolutionary modification/adaptation resembling a higher order species to survive harsh climatic changes (Werner 2015). From the following analysis we will get to know what these mites have in common with that of a spider and how do they differ. In arachnids, body colouration plays a vital role in their survival (Oxford and Gillespie 1998). As for example, *Stephanopis cambridgei* and *Synalus angustus* (*Thomisidae*), *Tama fickerti* (*Hersiliidae*), and *Dolophones conifera* (*Araneidae*) uses their body colour to camouflage with the surrounding (bark of the tree) (Mascord 1970), reduced predation on *Synageles occidentalis* due to their ant mimicry (Cutler 1991), salticid and lycosid spiders show sexual dimorphism and use their colours to attract the opposite sex for copulation (Crane 1949; Elias 2003; Peckham1889) and *Argiope argentata uses* and colour changing crab spiders *Misumena vatia* and *Thomisus onustus* uses their colours and patterns to protect themselves from predators orto catch prey (Craig and Ebert 1994; Théry 2009). T. *Grandissimum* also possess very bright red coloured velvety body covered with hairs. In other species the red colour is often considered as a signal for danger to other organisms. For example, *Latrodectus tredecimguttatus* and *Latrodectus* (*Theridiidae*) have bright red and black aposematic markings on their body which serve as defence mechanism to protect them from their potential enemies (Levi 1965; Bristowe 1941). It is expected that, may be their body colour also serves the same purpose of aposematism and thus protects them from predators. They don't have very tough skin but their skin is covered with thick hairs as an extra layer of protection which may also help them to keep warm in the winter. Under the skin, the haemolymph, which is surprisingly reddish in colour, unlike any other arthropods, serves as a cushioning fluid. Normally arthropods have whitish haemolymph whereas some arachnids have slight bluish one due to the presence of haemocyanin which contradicts with the colour of the body fluid present in these mites (Burmester 2004). The thick red haemolymph helps them to expand and contract and twist their bodies to wriggle through small burrows. When the body fluid is more, it is easier for the animal to turn and twist their bodies. That is why the reflex time for the larger and bulgier mites were found to be lesser than that of the smaller ones, since the body size and the amount of body fluid is more in them. Whereas due to bulky size of the larger ones, it becomes difficult for them to move fast and hence the speed varies inversely with their body size (Suter and Gruenwald 2000). They are terrestrial and burrowing in nature and their sharp claws at the distal end of their legs, help them to dig the soil. They have sensillary hairs at the tip of their front legs which serves as the main sensory organ just like other Arachnids (Foelix 1985; Albert, J., Friedrich, O., Dechant, HE. et al. 2001).Their body hairs are also very much susceptible to tactile sensation. They undergo hibernation for a long duration of the year and come out of their burrows in the monsoon, may beto avoid flooding of their burrows.

Animals living in burrows or caves have a tendency to avoid light as their eye sight becomes adjusted to uptake minimal amount of light. Such organisms also show a light avoidance property and hence show undergrown eyes or sometimes no eyes at all (Culver 1982). However, in case of red velvet mite this does not hold true. Although they undergo hibernation in the soil burrow for an extensive period of time, they are very much sensitive towards light and become excited in presence of light and get attracted towards it. Eye is a very costly device and it will not develop if it does not have any use. As for example, *Cupiennius salei*, wandering spider, are very much active at the night, performing 'sit and wait' predation to catch its prey without using web. As a result of that, they have evolved a very strong dark adapted eyesight and brightness discrimination ability with Weber fraction 1.4 times higher than that of day adapted organisms (Campione E. 2014). Since T. *grandissimum* undergo hibernation for a long duration of the year it is inevitable that their eyes are under developed. They probably have very less brightness discrimination ability because of which they are only active in presence of day light. They have very poor eye sight as well and they cannot recognise patterns or colours as we have concluded from our study. Arthropods, especially insects have special receptors to detect polarised light which help them in their navigation, to catch pray and to find source of water or moist substrate (Schwind1991). As these mites can sense polarised light it may be concluded that this helps them to navigate and to find water source. Their stalked eyes help them to get a wide range of view above the horizontal level. They have very poor frontal vision, and can only see objects kept at an angle of 60 degree from the horizontal plane in front of their head. This is probably due to their terrestrial nature. Since they crawl on horizontal surface they have this peculiar angle of vision so as to get a greater view above the horizontal plane. Also they have lateral vision and can see with the help of lateral pair of lenses. They were found to have UV signals on all side of their body. In *Cosmophasis umbratica* (jumping spider) distinct sexual dichromatism is found in males. The males have an elaborate UV body marking which signifies male quality. Female *C. umbratica* favourably choose male partners displaying UV signals and ignore the ones which are UV masked (Bulbert 2015). Butterflies also have ultraviolet markings on their wings which serve as sexual signals (Kemp and Rutowski 2007). Probably this serves as the same purpose and helps the mites in mating and finding their partners.

They were found to feed on termites and eggs of ants and even some dead insects. They have cannibalistic nature just like other Trombidiidae mites (Robaux 1974). They have good chemo-sensation property because of which they could distinguish between the termites and the harmful insect and even could sense ethanol without even touching. These property of olfactory response is not

uncommon in predatory mites as they are generally attracted towards volatile compounds secreted by herbivorous prey infested plants or Herbivorous Induced Plant Volatiles (Maeda 2001, 2006). The chemosensory hairs are assumed to be present on their front legs with which they keep on tapping on every object kept on their way.

They have many sensory hairs on the dorsal part of their front legs which helps them to sense poisonous chemicals, temperature, odour etc. Since they have poor eye sight they depend very much on their antennae like front legs. Apart from their front legs the hairs all over their body can sense touch and they respond to harsh and soft touches by contracting and expanding their body; this serves as a means of protection from any sort of external harm or injury. On harsh touch they contract their bodies to pretend to be dead in order to protect themselves from other predators. They retract their small heads along with the stalked eyes and hide under the thick tuft of hairs to protect from dust and soil and also the attack of other organisms.

They can tolerate high temperature. Since they live in arid and semi-arid regions with extreme weather conditions they had to sustain high temperature. This characteristic is also common in other Acari like Balaustium sp. (Hedges et al. 2011). They generally become active during the summer season before monsoon when the temperature is very high in Rourkela (the place where we have conducted the experiment). They become active during the morning but during the mid-day they move inside their burrows. However, on the other hand, they cannot resist cold and thus they were found to revert back as soon as coming in contact with the ice cubes. This characteristic is very common in most of the Arachnids. The special features about them are that they become very less active in low temperature and undergo hibernation.

They are extremely resistant to any chemicals like Ether. They have similar habitat and characteristics with their close resemblance Balaustium sp. nr. putmani (Erythraeidae). Balaustium sp. cannot absorb moisture from the atmosphere and thus they have to intake water along with their food to maintain hydrated condition (Yoder & Heydinger 2011). This characteristic physiology is also expected in T. *grandissimum* for which their skin colour darkened and became wrinkled when kept in dehydrated condition. The nymph and the intermediate ones were found to have less tolerance for dehydration and could not survive long without water in comparison to the adult ones. The most obvious reason for this is that their body size is directly proportion to the water content and hence the larger in size T. *grandissimum* were found to have more tolerance power. This presumably indicates that the adult ones have to live for a longer time in hibernation and thus they developed this ability to survive without water. The nymphs on the other hand, are parasitic in nature and thus do not have to depend on external water source. This unique characteristic plays a major role during the time of hibernation and also to sustain extreme climatic conditions.

In recent studies it has been proved that the spider mites *Tetranychus urticae* which undergo hibernation, changes its body colour from green to orange due to the synthesis of red coloured carotene pigments (Bryon et al. 2017). Carotene does not only serve as vitamin for them but also helps them during hibernation. This may have some relation with the bright red colour of T. *grandissimum*. T.*grandissimum* belonging to the same order as spider mites spend an extensive period of time in hibernation under the soil. This might be the reason why they also depend on such kind of red pigments for which their haemolymph is unusually red in colour.

In their natural habitat they were found to move on horizontal plane. They seemed to be reluctant to climb up against the gravitational force may be due to their bulky body size and shorter legs. They can easily wriggle their bodies through small openings and thus can easily get inside the burrows of ants and other insects to feed on their eggs. Males and females of Trombidiidae mites perform encircling dances, after which they pair for mating (Moss 1960). This behaviour is also expected in T. *grandissimum* as they were also found to perform similar kind of movements while studying in their natural habitat. A dead mites was found to be surrounded by ants suggesting that they are non-toxic to other species (Fig.8d). Also their cannibalistic nature suggests the same.

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